

## **REMARKS**

In view of the foregoing amendments and the following remarks, Applicants respectfully request reexamination of the present application. Claims 1, 29, 62 and 84 have been amended, Claims 5, 30-32, 63 and 64 have been cancelled and no new Claims have been added.

### **CLAIM REJECTIONS – 35 USC § 101**

The Examiner has provisionally rejected Claims 1-98 under 35 U.S.C. 101 as claiming the same invention as that of Claims 1-43, 45 and 48-65 of co-pending Application No. 10/996,791. The Examiner states that Claims 1-98 of this application conflict with Claims 1-65 of Application No. 10/996,791. The Examiner states that 37 C.F.R. 1.78(b) provides that when two or more applications filed by the same applicant contain conflicting claims, elimination of such claims from all but one application may be required in the absence of good and sufficient reason for their retention during pendency in more than one application. The Examiner states that Applicant is required to either cancel the conflicting claims from all but one application or maintain a clear line of demarcation between the applications.

In view of the foregoing amendments, Applicants request removal of this rejection under 35 USC §101 as it is not believed that the identical invention is now being claimed in each application.

### **CLAIM REJECTIONS – OBVIOUSNESS-TYPE DOUBLE PATENTING**

The Examiner has also provisionally rejected all pending claims on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-65 of copending Application No. 10/996,791. The Examiner states that although the conflicting claims are not identical, they are not patentably distinct from each other because the claims of 10/723,424 and 10/996,791 disclose a method for converting a carbon-based fuel into a hydrogen-rich product gas using similar process steps.

More specifically, the Examiner states that the difference between the claims of 10/723,424 and the claims of 10/996,791 is that Claims 44, 46 and 47 in 10/996,791 describe the temperature; gas hourly space velocity and water:carbon ratio in the same process, however it is the Examiner's position that this difference would have been obvious to one of ordinary skill in the art at the time the invention was made because it is reasonably expected that the same process will inherently operate at the same claimed temperatures; gas hourly space velocity and water:carbon ratios. The Examiner states that the courts have already determined that mere recognition of latent properties in the prior art does not render nonobvious an otherwise known invention: please see the discussion of the *In re Wiseman*, 596 F.2d 1019, 201 USPQ 658 (CCPA 1979) court decision set forth in section 2145(II) in the MPEP, 8<sup>th</sup> Ed., Rev. 3, Aug. 2005.

Since none of the claims of these applications have been patented, Applicants request that this rejection obviousness-type double patenting rejection be held in abeyance until patentable subject matter is indicated in at least one of the applications.

#### **CLAIM REJECTIONS – 35 USC § 103**

The Examiner has rejected Claims 1-98 under 35 U.S.C. 103(a) as being unpatentable over "Hydrogen Production from Coal by Separating Carbon Dioxide During Gasification" by Lin et al. The Examiner states that the abstract of Lin et al. reports that hydrogen generation during the reaction of a coal/calcium oxide mixture with steam was investigated. The Examiner also states that coal, calcium oxide and carbon monoxide reactions with steam and carbon dioxide absorption by calcium hydroxide or calcium oxide occurred simultaneously in the experiment and it was found that hydrogen was the primary resultant gas and carbon dioxide was fixed into calcium carbonate.

The Examiner has also rejected Claims 1-98 under 35 U.S.C. 103(a) as being unpatentable over the article titled "Hydrogen Production Using Sorption-Enhanced Reaction" by Lopez Ortiz et al. The Examiner states that the abstract of Lopez Ortiz et al. discloses the sorption-enhanced production of hydrogen via the steam-methane reforming process using a mixture of nickel-based reforming catalyst and a calcium-based sorbent and the rates of the reforming, water-gas shift and carbon dioxide

removal reactions are sufficiently fast that combined equilibrium was closely approached, allowing for greater than 95 mol. % of hydrogen to be produced in a single step.

The Examiner has also rejected Claims 1-98 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,682,838 by Stevens. The Examiner states that Claim 1 of Stevens describes a process for converting a hydrocarbon fuel into hydrogen-rich gas, comprising reacting the hydrocarbon fuel with steam in the presence of a reforming catalyst and a carbon dioxide fixing material to produce a first hydrogen gas; removing carbon monoxide from the first hydrogen gas to produce the hydrogen-rich gas, and regenerating the carbon dioxide fixing material by heating the carbon dioxide fixing material to a temperature of at least about 600°C.

The Examiner has also rejected Claims 1-98 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication 2002/0085967 by Yokota. The Examiner states that Claim 1 in the Yokota describes a process for generating hydrogen comprising contacting a gas comprising fuel and steam with a reactor bed comprising a reforming catalyst and a carbon dioxide absorbent, thereby converting the gas into hydrogen and absorbing the co-generated carbon dioxide into the carbon dioxide absorbent, and heating the reactor bed, thereby desorbing the carbon dioxide from the absorbent and regenerating the absorption capacity of the absorbent.

The Examiner has also rejected Claims 1-98 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 4,231,760 to Lancet et al. The Examiner states that Claim 1 of Lancet et al. describes a process for producing synthesis gas by reacting a carbonaceous fuel with water in the presence of a carbon dioxide acceptor comprising calcium oxide to produce a synthesis gas rich in hydrogen with at least a portion of the produced carbon dioxide being reacted with the calcium oxide to produce calcium carbonate.

For each of the foregoing rejections, the Examiner states that the difference between the Applicants' claims and the cited patent or publication is that the Applicants' claims call for repeating the absorption and regeneration step at least 10 times, wherein the absorbent material retains at least about 50 mol.% of the theoretical absorption capacity after each of the regenerating steps. The Examiner's position is that this

difference would have been obvious to one of ordinary skill in the art at the time the invention was made because it is reasonably expected that the processes disclosed in these documents would also undergo the same number of absorption and regeneration steps when treating the same gas with the same amount of carbon dioxide with the same absorbent in the same quantity, as a function of mass balance.

Applicants traverse this rejection. The present application is directed to absorption enhanced reformation (AER) of a carbon-based fuel, such as ethanol or gasoline, to form a product gas rich in  $H_2$ . The method includes the use of an absorbent material to absorb  $CO_2$ . The absorbent material advantageously has the ability to be regenerated (i.e., where the  $CO_2$  is desorbed from the absorbent) many times without losing a substantial amount of absorption capacity. In the prior art,  $CO_2$  absorption materials lose their capacity to absorb  $CO_2$  after several cycles of absorption and desorption.

This phenomena is clearly recognized by at least two of the references relied upon by the Examiner in rejecting the present claims. Lopez Ortiz et al. states at page 5102 that:

"The economics of a commercial sorption-enhanced  $H_2$  production process require that the sorbent and catalyst maintain activity through numerous reaction-regeneration cycles, and none of the earlier studies, including the work in this laboratory seriously examine the question of multicycle durability."

In this regard, Lopez-Ortiz et al. "reports experimental results of multicycle tests from a laboratory-scale fixed-bed reactor using inexpensive dolomite as the sorbent precursor."

Further, the patent by Lancet et al. discloses that  $CaO$  has been utilized as a  $CO_2$  acceptor material and that "in the practice of such processes a continuing problem has been the tendency for the calcium oxide to become inactive after several cycles through the process." (Col. 1, lines 39-52).

Thus, those skilled in the art clearly recognize that multiple sorption-desorption cycles typically deteriorate the ability of the CO<sub>2</sub> absorber material to continue to absorb CO<sub>2</sub>. Applicants submit that the ability to cycle a CO<sub>2</sub> absorber material as recited in the present claims is not obvious in view of the references relied upon by the Examiner, as the prior art materials are not capable of maintaining a high absorption capacity over many cycles.

**Lopez Ortiz et al.**

According Lopez-Ortiz et al., tests were conducted on a dolomite-based material (CaMg(CO<sub>3</sub>)<sub>2</sub>) for use as the carbon dioxide absorbent. Referring to pages 5107-5108 of Lopez-Ortiz et al., it is disclosed that two longer-duration dolomite calcination-carbonation tests were carried out, the first test lasting 33 cycles and the second test lasting 148 cycles. The results are illustrated in Fig. 11 on page 5108 of Lopez Ortiz et al. Although it is disclosed that the results in Fig. 11 for these "electrobalance" tests represent the degree of carbonation achieved under the specified conditions, not the maximum achievable carbonation, the inclusion of the fractional carbonation results from the 25-cycle reaction-regeneration test from the fixed bed reactor, which were carried out to completion of the reaction, are also included in Fig. 11, and these results do not significantly deviate from the electrobalance test results.

It is seen from these results that the fractional carbonation rapidly decreased from a range of about 0.80 to 0.87 in the first cycle. By cycle 50, much less than 50% of the absorbent available for carbonation was carbonized. In the 148-cycle test, the fractional carbonation decreased from 0.83 in cycle 1 to 0.26 in cycle 97. Lopez Ortiz et al. concludes that "The experimental evidence suggests that most of the multicycle activity loss is associated with the sorbent" (page 5109). Thus, Lopez Ortiz et al. is directed to solving the same problem as is addressed in the present claims, the regeneration of a CO<sub>2</sub> absorbent over multiple cycles, however Lopez Ortiz et al. was unable to achieve the method that is recited in the present claims.

Independent Claim 1 has been amended to recite that the absorption-regenerating steps are repeated at least 50 times and that the absorbent material retains at least about 50 mol.% of its theoretical absorption capacity after each of the repeating

steps. At best, Lopez-Ortiz et al. discloses a fractional carbonation of about 0.44 after 50 cycles (Fig. 11). Therefore, removal of this rejection is requested.

With respect to independent Claim 29, Applicants have amended the claim to incorporate the limitation of Claim 32 that the mass of absorbent material retains at least about 40 grams CO<sub>2</sub> per 100 grams of unreacted absorbent after each of the repeating steps. In the case of the dolomite material disclosed by Lopez-Ortiz et al., the maximum CO<sub>2</sub> absorption is about 46.1 grams CO<sub>2</sub> per 100 grams dolomite. Thus, at 40 grams CO<sub>2</sub> per 100 grams of unreacted absorbent, the dolomite would need to maintain a fractional carbonation of about 0.868 over each of 10 cycles. As is illustrated in Fig. 11, Lopez-Ortiz et al. does not meet this requirement. Therefore, removal of this rejection with respect to independent Claim 29 is also requested.

Independent Claim 62 has been amended to incorporate the limitation of dependent Claim 64, namely that the absorbent material retains at least about 60 mol.% of its theoretical CO<sub>2</sub> absorption capacity after each repeating step when the steps are repeated at least 50 times. As is discussed above, Fig. 11 of Lopez Ortiz et al. clearly demonstrates that the material disclosed by Lopez Ortiz et al. does not meet this requirement. Therefore, removal of this rejection of independent Claim 62 is also requested.

Regarding independent Claim 84, there is no disclosure or suggestion by Lopez Ortiz et al. that the absorbent compound is pelletized, and that the bulk density of the absorbent material decreases after being carbonized and regenerated. Therefore, removal of this rejection is also requested.

#### **Lancet et al.**

Lancet et al. is also directed to a CO<sub>2</sub> absorber material having regeneration capability in a coal gasification process using a fluidized bed. The material includes a calcium silicate matrix (Ca<sub>5</sub>(SiO<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>) with free calcium carbonate (CaCO<sub>3</sub>) dispersed in the matrix. The calcium carbonate is present in an amount up to about 50 wt.% (calculated as CaO) based on the total weight of the particles (Col. 4, lines 15-18). Thus, the *maximum* amount of actual absorbent in the material is 50 wt.%. Applicants have amended independent Claims 1, 29, 62 and 84 to recite that the carbon-based fuel

is selected from a liquid fuel or a gaseous fuel. Support for this amendment can be found, for example, in dependent Claims 20, 22, 53, 55, 88 and 90. Applicants also note that each of the independent claims require that the carbon-based fuel is converted to an intermediate gas product in the presence of a *catalyst*. In contrast, Lancet et al. is directed to the use of a fluidized bed to gasify particulate materials, such as coal or char, by fluidizing with steam (Col. 2, lines 14-17). Thus, Lancet et al. is not applicable to the treatment of liquid or gaseous fuels and would have no reason to utilize a catalyst to gasify the solid coal or char. Therefore, removal of the rejection over Lancet et al. is requested.

#### **Lin et al.**

As with Lancet et al., Lin et al. is also directed to coal gasification and is not directed to the conversion of liquid or gaseous type fuels or the use of a conversion catalyst. Further, Lin et al. does not disclose or suggest that the CO<sub>2</sub> absorbent used therein is not subject to the same limitations as is described in the background of the present application, as well as in Lopez Ortiz et al. and Lancet et al. Indeed, the CaO used by Lin et al. was made by calcination of a commercially available Ca(OH)<sub>2</sub> powder (page 2081 of Lin et al.) and no cycling results are listed. Thus, it is reasonable to assume that the material would be subject to the same limitations that are described in detail in the prior art. Therefore, Applicants request removal of the rejection over Lin et al.

#### **Yokota**

Yokota discloses the generation of hydrogen from fuels using absorption enhanced reforming. The absorbent utilized by Yokota can be an oxide of an alkali metal or alkaline earth metal [Paragraph 0063] which is dispersed on an inorganic porous support, such as MgAl<sub>2</sub>O<sub>4</sub> or ZrO<sub>2</sub>. No particular fabrication method is preferred for the absorbent material. Further, there is no disclosure or suggestion by Yokota that the absorbent material utilized therein is not subject to the same limitations as the prior art materials discussed in the present application and discussed by Lopez Ortiz et al. and Lancet et al. Thus, it is submitted that the absorbent of Yokota would be subject to

the same limitations and would not be capable of use in the method recited in the pending claims. Therefore, removal of the rejection over Yakota is also requested.

### **Stevens**

Likewise, Stevens is directed to the generation of hydrogen from fuels using absorption enhanced reforming. The absorbent utilized by Stevens can be selected from a long list of compounds (Col. 2, lines 2-15) and no particular fabrication method is preferred for the absorbent materials. Further, there is no disclosure or suggestion by Stevens that the absorbent material utilized therein is not subject to the same limitations as the prior art materials discussed in the present application and discussed by Lopez Ortiz et al. and Lancet et al. Indeed, the examples of Stevens utilize a commercially available dolomite absorbent similar to the material tested at length by Lopez Ortiz et al. and discussed above (see Col. 8, lines 48-62). Although the gas product over 10 cycles is disclosed in Fig. 6 of Stevens, no data is provided with respect to performance of the dolomite absorbent over 10 cycles. Thus, it is submitted that the absorbent of Stevens would be subject to the same limitations discussed above and would not be capable of use in the method recited in the pending claims since the absorption capacity would decrease significantly over multiple cycles. Therefore, removal of the rejection over Stevens is also requested.

Applicants do not believe that any fees are due with respect to the filing of this paper, however if any fees are required please charge the fee to Deposit Account No. 50-1419.



Applicants believe that all pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone conversation would further prosecute and or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

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